

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD

CONSTRUCTED WETLAND

Code 656



**DEFINITION**

A constructed shallow water ecosystem designed to simulate natural wetlands.

**PURPOSE**

This practice may be applied as part of a conservation management system to reduce the pollution potential of wastewater discharges to water resources, or runoff from agricultural lands to water resources. This practice is not to be applied as compensation for wetland losses (i.e., constructed wetlands cannot be used as mitigation for impacts to natural wetlands).

**CONDITIONS WHERE PRACTICE APPLIES**

This practice applies:

- where a constructed wetland is a component of a planned conservation system or agricultural waste management system
- where wastewater or runoff originates from agricultural lands including livestock, poultry, aquaculture, or nursery facilities
- where a constructed wetland can be constructed, operated and maintained without polluting air or water resources

**CRITERIA**

**General Criteria Applicable To All Purposes**

**Laws and Regulations.** All federal, state, and local laws, rules and regulations governing the use of constructed wetlands shall be followed. Constructed wetlands for wastewater treatment shall not be designed to discharge to waters of the state unless permitted by state laws and regulations, and appropriate permits have been obtained. In addition, if discharge is permitted, the receiving surface water must have the capacity to assimilate the constructed wetland's effluent during low flow periods.

**Location.** Constructed wetlands shall be located outside the limits of natural wetlands of any classification. Constructed wetlands located within a floodplain shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations.

Constructed wetlands shall be located to provide sufficient separation distance and utilization of prevailing winds and landscape elements (e.g., building arrangement, landforms, and vegetation) to minimize odors and protect aesthetic values. They shall be located with a horizontal and vertical separation distance that will minimize the potential for contamination of ground water resources.

**Type.** Constructed wetlands shall be designed as surface flow systems consisting of adequate seepage control, a suitable plant medium, rooted emergent hydrophytic vegetation (in some cases floating or submerged vegetation may be appropriate as well), and the structural components needed to contain and control the flow.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

**Influent.** The influent shall be pretreated to reduce the concentrations of solids, organics, and nutrients to levels that will be tolerated by wetland plants and not cause excessive accretion within the wetland.

Where significant sediment and organic debris are expected in the wastewater or runoff to be treated, provisions for its entrapment before entry into the wetland shall be provided. The entrapment area will be cleaned and the accreted material disposed of according to NRCS conservation practice standards Waste Utilization, Code 633 and Nutrient Management, Code 590.

**Water budget.** The required wetland size and storage requirements shall be based on a water budget that evaluates runoff or wastewater volumes, precipitation, evaporation, and water use. In addition, the wetland size shall include the required hydraulic retention time when pretreatment and post treatment facilities are included.

**Embankments.** The perimeter embankment shall have a minimum top width of 10 feet. Interior embankments shall have a minimum top width of 8 feet. If site conditions will not permit the required top width, narrower widths may be used if suitable provisions are included in the Operation and Maintenance plan for vegetation maintenance and embankment repair. All embankment side slopes shall be a minimum ratio of 2 horizontal to 1 vertical (2:1).

**Vegetation.** Vegetation selected for the constructed wetland shall be hydrophytic plants suitable for local climatic conditions and tolerant of the concentrations of nutrients, pesticides, and other constituents in the runoff or wastewater stream. Species shall be selected for their treatment potential.

Preference shall be given to native wetland plants with localized genetic material. Wherever possible, avoid harvesting native plants from existing wetlands, as this practice may be prohibited for certain species or geographic areas and may be detrimental to natural wetlands.

To avoid damage to vegetation, livestock shall be excluded from the constructed wetland.

**Planting medium.** The soil used for the planting medium shall have a cation exchange

capacity, pH, electrical conductivity, soil organic matter, and textural class that is conducive to wetland plant growth and retention of contaminants.

**Seepage control.** The constructed wetland shall be located in soils with an acceptable permeability that meets all applicable regulations, or it shall be lined. Measures for controlling seepage shall be designed according to the procedures of NEH Part 651, Agricultural Waste Management Field Handbook, Appendix 10D, "Geotechnical Design and Construction Guidelines."

### **Additional Criteria for Wastewater Treatment**

**Topography.** Site topography shall accommodate the requirements for length to width ratios of the wetland and the wetland cells, and the requirement that the wetland cells be level side to side and grades of less than 0.1 ft/ft lengthwise.

**Inlet.** An inlet structure shall be provided that will allow control of flow discharged to the wetland and screening of influent to prevent debris from entering wetland. Design of the inlet structure shall assure its function throughout the life of the wetland considering accretion. Criteria in NRCS conservation practice standard Waste Storage Facility, Code 313, for fabricated structures shall apply as appropriate.

**Influent.** Constructed wetlands for wastewater treatment shall not allow for direct inclusion of contaminated and/or uncontaminated runoff.

Wastewater shall be of sufficient volume and duration to keep the constructed wetland moist at all times or accommodations shall be made for the addition of supplemental water.

**Surface Area.** The surface area of the wetland shall be determined using a recognized design procedure in consideration of loading, temperatures, and the desired level of treatment.

**Configuration.** The constructed wetland shall have an overall length to width ratio of 1:1 (minimum) to 4:1 (maximum). Individual cells within the constructed wetland shall have a length-to-width ratio of 10:1 (minimum) to 15:1

(maximum). The wetland shall consist of at least two rows of parallel cells.

**Flow depth.** The design depth shall be based on the most severe season of operation, the desired level of treatment, and the required littoral zone of the plant species being used. The design depth shall be a minimum of 0.33 foot and a maximum of 1.5 feet.

**Embankments.** Height of the constructed wetland perimeter embankment shall be the sum of the following:

- Design depth
- Wetland accretion -- a minimum of 1 inch per year for the cleanout interval
- 25-year, 24-hour precipitation
- 12 inches of freeboard
- Hydraulic head on overflow device

The height of wetland's interior embankments shall be the minimum of the sum of the following:

- Normal design flow depth
- Wetland accretion -- minimum of 1 inch per year for the cleanout interval

**Overflow Device.** An ungated overflow device shall be provided to operate when the 25-year, 24-hour precipitation is exceeded. The overflow device shall operate without infringing on the wetland perimeter embankment's freeboard.

**Outlet.** Constructed wetlands shall discharge to storage facilities to allow for land application in accordance with NRCS conservation practice standards Waste Utilization, Code 633 and Nutrient Management, Code 590 or recycled through the waste management system.

An outlet structure shall be provided that allows maintenance of proper water level in the wetland and controls the flow from the wetland.

**Cleanout.** The waste treatment cells shall be designed so that each of the parallel cells can be completely drained in order to accomplish periodic maintenance and removal of accreted material.

### **Additional Criteria For Runoff Treatment**

**Design Storm.** The constructed wetland system shall be designed to contain a 2-year, 24-hour storm runoff. Limited area sites handling only the "first flush" volume shall have a minimum capacity to store 0.5 inch of runoff volume from the entire drainage area. When less than full runoff is stored, bypass of the excess storm flow shall be provided.

**Detention Time and Surface Area.** The detention time and surface area shall be calculated on the time required to achieve the required level of treatment based on the limiting contaminant present.

**Wetland Cells.** Length to width ratios are to be 4:1 to 10:1. Other dimensions and shapes that provide a more natural landscape appearance that meet treatment requirements can be used.

NRCS conservation standards for Dike, Code 356 and Structure for Water Control, Code 587 shall be used as appropriate. Refer to the NRCS Engineering Field Handbook, Chapter 13, "Wetland Restoration, Enhancement, and Creation," and Chapter 6, "Structures," for additional design information. Existing drainage systems shall be utilized, removed, or modified as needed to achieve the intended purpose.

**Depth.** Maximum water depth shall be 24 inches except in those instances where deep water areas are included as a special design. The maximum depth can be deeper than 24 inches if provisions are made to drain the constructed wetland down to the 24-inch level within 72 hours. This will allow for additional settlement of solids without damaging the wetland vegetation.

**Overflow Device.** An ungated overflow device shall be provided to operate when the 25-year, 24-hour precipitation is exceeded. The overflow device shall operate without infringing on the wetland perimeter embankment's freeboard.

**Outlet.** A water control structure to automatically regulate storage release in accordance with the design detention time shall be installed.

## CONSIDERATIONS

Locate constructed wetlands downgrade and as near the source of wastewater as practical.

In addition to selecting vegetation based on treatment potential, consider the specie's suitability as a physical substrate for attached organisms (e.g., algae, bacteria).

Install measures to exclude or minimize attractiveness of the constructed wetland to wildlife that could be adversely affected by the constructed wetland. Take measures to exclude burrowing animals. Consider the use of fences to exclude livestock and wildlife to maintain embankment integrity.

Recycle constructed wetland effluent back through the agricultural waste management system when practical.

Consideration may be given to the ancillary use of the constructed wetland area for the commercial production of wetland plants. Selective harvesting and sale of wetland plants may be a potential source of income.

## PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use. Plans shall include construction sequence, vegetation establishment, and operation and maintenance requirements.

## OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

Operational requirements shall include:

- Maintenance of water level in wetland cells appropriate for vegetation
- Control flow to wetland according to water budget
- Monitoring of wetland performance
- Sampling effluent for nutrients prior to utilization
- Surveillance of inlet and outlet

Maintenance requirements shall include, as appropriate:

- Repair of embankments
- Control of vegetation
- Repair of fences or other ancillary features
- Replacement of wetland plants
- Repair of pipelines
- Control of nuisance activity by animals
- Removal of accreted sediments from waste treatment cells

## REFERENCES

Engineering Field Handbook, Chapters 6, 13

NRCS Conservation Practice Standards:

Dike, Code 356  
Nutrient Management, Code 590  
Structure for Water Control, Code 587  
Waste Storage Facility, Code 313  
Waste Treatment Lagoon, Code 359  
Waste Utilization, Code 633

NEH Part 651, Agricultural Waste Management Field Handbook, Appendix 10D, "Geotechnical Design and Construction Guidelines"